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(54) **High gloss coated paper and process for its preparation**

(57) A coated paper product having high gloss and brightness is prepared by a process wherein a paper substrate is coated on at least one side with an aqueous coating formulation comprising an effective amount of a plastic pigment, and finished in a supercalender device containing heated rolls to produce a surface which is comparable to a cast coated surface.

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## Description

### BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to a coated paper product having high gloss and brightness and the method of manufacturing such a product. In particular, the invention relates to a process for manufacturing a coated paper product with a surface comparable to a cast coated surface, that may be used, for example, as the facing sheet of a pressure sensitive laminate. In addition to this intended use, the product of the present invention is suitable for a variety of other printing and converting operations such as metallizing, foil laminating and printing, security label applications and, specialty packaging as well as upscale gift wrap and labels.

[0002] Such paper products have in the past been produced almost exclusively by a cast coating process. During cast coating, gloss development relies on a replication of the mirror-like finish on a dryer roll, as the applied coating is dried. However, production rates for the cast coating process are considerably slower than the production of coated paper on a high speed papermachine. Thus it would be desirable and advantageous to develop a high speed coating process that could be used to produce a cast coated surface on paper. Examples of the cast coating process are disclosed in prior United States patents Nos. 4,241,143 and 4,301,210.

[0003] Another method for producing high gloss paper is disclosed in United States Patent No. 5,360,657. In this patent, a process is disclosed in which a thermoplastic polymeric latex having a second order transition temperature of at least 80 degrees C., and an average particle size smaller than 100 microns is applied to paper which is subsequently calendered to produce high gloss. Other methods for producing high gloss paper include the application of a glossy overprint varnish onto a previously coated substrate. However, in the latter case, the glossy surface produced is not generally useful for offset printing because of the excessive ink drying time required.

[0004] It is also known, as disclosed for example in PCT published application WO 98/20201, that a printing paper having high brightness and gloss can be manufactured by applying to paper a coating comprising at least 80 parts precipitated calcium carbonate and at least 5 parts of an acrylic styrene copolymer hollow sphere plastic pigment. The published application also notes that a finishing step using a calender is required to achieve the gloss development, but the method of calendering is deemed to be not restrictive. Likewise, in an article entitled "Lightweight Coated Magazine Papers," published in the July 5, 1976 issue of the magazine PAPER, Vol. 186, No.1, at pages 35-38, a relationship between calendering and the use of plastic pigments in coatings is disclosed. The article notes that polymers such as polystyrene are thermoplastic and pressure Sensitive, and a pigment based on polystyrene will exhibit a high degree of calendering response.

[0005] These and other publications including an article entitled "Light Reflectance of Spherical Pigments in Paper Coatings," by J. Borch and P. Lepoutre, published in TAPPI, February 1978, Vol. 61, No. 2, at pages 45-48; an article entitled "Plastic Pigments in Paper Coatings," by B. Aluice and P. Lepoutre, published in TAPPI, May 1980, Vol. 63, No. 5, at pages 49-53; and an article entitled "Hollow-Sphere Polymer Pigment in Paper coating," by J. E. Young, published in TAPPI, May 1985, Vol. 68, No. 5, at pages 102-105, all recognize the use of polymer pigments in paper coatings; but none of these publications disclose the unique combination of coating formulation and finishing conditions disclosed herein.

### Summary of Invention

[0006] The present invention relates generally to a coated paper product, a method of producing it, a coating composition per se and use thereof to coat a surface, preferably paper. More particularly, the invention relates to a coated paper product that can be manufactured on a high-speed papermachine and still achieve a high gloss, high brightness surface typical of cast coated paper.

[0007] According to a first aspect, the present invention relates to a coating formulation which may be used to coat a surface, preferably at least one paper surface, comprising a pigment composition comprising by weight from about 14-35% of a plastic pigment selected from the group consisting of hollow sphere pigments and solid bead pigments. Preferably, said pigment composition comprises a solvent which is most preferably water thereby being an aqueous coating composition. Even preferably, said solvent, preferably water, is present in a amount sufficient to provide a coating composition with a solids content of from about 45 to 60 %.

[0008] According to a particularly advantageous embodiment, said pigment composition comprises from 14-35 % plastic pigment selected from the group consisting of hollow sphere pigments and solid bead pigments; 46-60 % calcium carbonate, about 0-33 % coating clay and water in an amount sufficient to provide to said composition a solid content of from about 45 to 60 %. This composition may also comprise a binder and in particular from about 10 to 12 parts by weight of binder based on the pigment composition.

[0009] Other particular embodiments of the invention coating composition appear from the herebelow description and of the claims which are incorporated in their entirety by reference.

[0010] According to a second aspect, the present invention also relates to the use of the invention coating composition for coating a surface, preferably at least one surface of paper in one or more coating layers, advantageously to form at least the final coating layer.

[0011] According to a third aspect, the present invention relates to a coated paper obtained by coating with the inventor coating composition. Preferably, this coated paper has applied to at least one surface thereof the dried residue of from about 2.72 to 8.16 kg/278.7 m<sup>2</sup><sub>a</sub> (6-18 lbs/ream) ream size 278.7 m<sup>2</sup><sub>a</sub> (ream size 3300sq. ft.) of said coating composition as above defined, preferably an aqueous coating composition. According to a particular embodiment,

said coated paper having at least a final or apparent coating layer coated with the invention coating composition, is exhibiting a 75 degree paper gloss of at least about 90, a 60 degree paper gloss of at least about 55, 20 degree paper gloss of at least about 35, and a Parker Print Surf of from about 0.44 to 0.65.

[0012] According to a fourth aspect, the present invention further relates to a method of manufacturing coated paper having high gloss and brightness comprising applying to at least one surface of the paper of a coating composition, preferably an aqueous coating composition as above and herein after defined in the description or as defined in the claims, in one or more coating layers, wherein the final coating layer comprises, by weight, from about 14-35 % plastic pigment selected from the group consisting of hollow sphere pigments and solid bead pigments.

[0013] A preferred paper for using the invention is a paper rawstock having a basis weight of at least about 18.14 kg/278.7 m<sup>2</sup><sub>a</sub> (40 lbs/rm) (ream size 3300 sq. ft.).

[0014] According to a particularly advantageous embodiment, the coated paper is finished in a supercalender device by passing the paper through a plurality of nips at a load of from about 680-907 kg/linear 2.54 cm (1500-2000 pli), wherein at least one of the nips includes a heated roll having a surface temperature of from about 37.7-115.4 °C (100-240 degrees F.) in contact with the coated surface of the paper.

[0015] According to another advantageous invention embodiment, it is obtained or prepared a paper having high gloss and brightness suitable for printing high quality graphics wherein at least one surface thereof contains from about 2.72-8.16 kg/278.7 m<sup>2</sup><sub>a</sub> (6-18 lbs/ream) of the dried residue of a coating composition, preferably an aqueous coating composition, said coating composition comprising a pigment composition comprising coating clay, calcium carbonate and plastic pigment, said plastic pigment consisting essentially of hollow spheres and/or solid bead particles ranging in size from about 0.20-1.0 micron, wherein at least about 18 % of the printing surface contains plastic pigment to achieve a 75 degree paper gloss of at least about 90, a 60 degree paper gloss of at least about 55 and a 20 degree paper gloss of at least about 35.

[0016] The coatings disclosed herein for practicing the present invention include conventional inorganic pigments such as clay and calcium carbonate in conjunction with elevated amounts of thermoplastic polymer latex beads. The beads are either hollow or solid in composition. Upon applying these coatings onto an uncoated but smoothened basestock, or onto a precoated basestock, it is possible to achieve a high gloss and smoothness with good printing properties when the coated surface is finished in a calendar device such as a supercalender containing heated rolls.

[0017] Paper produced with the high plastic pigment content coating preferred for the present invention is suitable for printing using conventional printing methods including sheet-fed litho offset, flexography, rotogravure and web offset.

[0018] The high gloss coatings of the present invention comprise standard coating pigments such as clay, ground or precipitated calcium carbonate, titanium dioxide and elevated amounts of plastic pigment. While the content of plastic pigment in the coating formulation plays a significant role in achieving high gloss, an equally important factor which contributes to the desired finished paper properties is the surface area of the paper which comprises plastic pigment.

[0019] SEM micrographs of coated paper surfaces were analyzed for plastic pigment spheres on the surface of the paper. The number of spheres were counted and an approximate percent of the total area of the sheet was calculated. The results showed an effect of coating speed/coating solids on plastic sphere areas as a percent of surface area. It was noted that as coating speed increased, a greater amount of surface area was filled with plastic spheres producing greater gloss development. The reason for this is not clear, but one possible explanation is that at increasingly higher coating speeds, drying is more intense, and as water is driven from the coated surface during drying, the plastic spheres (being of equivalent density when filled with water and of lower density as water is evaporated), are transported through the coating to the surface of the coated paper. Therefore to achieve a target gloss, lower amounts of plastic pigment may be used when the method and speed of the coating application is taken into account.

[0020] In addition, the size of the plastic pigment plays a role in the performance of the coating, vis-a-vis gloss development. For example, paper gloss achieved with a 0.45 micron diameter solid sphere plastic pigment is not as good as that obtained with a hollow sphere plastic pigment when the percent of surface area is taken into consideration. It is postulated that this ineffectiveness may be related to the diameter and curvature of the sphere presented to incoming light and subsequent light scattering. For example, five 0.45 micron diameter solid spheres will occupy approximately the same space as a 1.0 micron diameter hollow sphere. However, hollow spheres can flatten upon calendering and create a plurality of multiple flat surfaces for more efficient light reflection and gloss development. Meanwhile, the use of a 0.20 micron diameter solid sphere plastic pigment will more closely simulate a flatter surface than the 0.45 micron diameter spheres because approximately twenty five 0.20 micron diameter spheres will occupy the same space as a single 1.0 micron diameter hollow sphere.

[0021] In summary, the preferred coating formulation for achieving the results of the present invention comprises, by weight, from 46-60% calcium carbonate, 0-33% coating clay, 0-5.5% titanium dioxide and from 14-35% plastic pigment. The preferred plastic pigment is a hollow sphere plastic pigment having a particle size of up to 1.0 micron diameter selected from the group consisting of polystyrene, acrylics and methacrylates. However, solid sphere plastic pigments ranging from 0.20-0.45 micron diameter may be substituted for the hollow sphere pigment or blended with the hollow sphere pigment as desired.

[0022] The preferred finishing step in the manufacture of the high gloss coated paper disclosed herein involves a supercalender apparatus operated at speeds ranging from about 244-853 meters per minute (800-2800 fpm), and at calender loads of from about 680-907 kg/linear 2.54 cm (1500-2000 pli), with one or more rolls heated to a temperature of from about 37.7-115.4°C (100-240 degrees F). It should be noted, however, that gloss development equivalent to that obtained with a supercalender apparatus may be obtained with a gloss calender or soft roll calender under appropriate operating conditions.

#### Brief Description of the Drawing

[0023] The Figure of drawing is a plot showing the percent surface area containing plastic pigment vs. the percent plastic pigment in the coating.

#### Detailed Description

[0024] The present invention will be more fully understood by reference to the following Examples.

#### Example 1

[0025] Coatings containing from 7% to 35% of a hollow sphere plastic pigment having a diameter of 1.0 micron (Rohm and Haas HP-1055), were applied onto base stock having 4.54 kg/278.7 m<sup>2</sup><sub>A</sub> (10.0 lb/rm) precoat and no precoat. The coatings were applied with a laboratory coater at a speed of about 30.48 meters per minute (100 fpm). Coated paper samples were then supercalendered. Paper gloss and smoothness data are shown in Table 1. The 4.54 kg/278.7 m<sup>2</sup><sub>A</sub> (10.0 lb/rm) precoat sample achieved a 75° paper gloss greater than 91 with 14% or more plastic pigment in the coating. 60° gloss was 62 to 75, and 20° gloss was 30 to 37 for the same samples. As the plastic pigment level was increased, higher gloss values could be achieved at lower coat weight. Print gloss also increased with increased levels of plastic pigment in the coating. For the uncoated base stock, 75° paper gloss values of 84-94 were obtained; 60° gloss was 48-58, and 20° gloss was 20-24. Finished smoothness was less than on pre coated base stock, which is what would be expected. Compared to the cast coated control, gloss and smoothness values were met or exceeded.

Table 1.

Condition	% Coating Pigment	75° Paper Gloss	60° Paper Gloss	20° Paper Gloss	Parker Print Surf @ 10kg	Coat Wt.kg/ 278.7 m <sup>2</sup> (lb/rm)
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Base Stock: 4/54 kg/278.7m<sup>2</sup> (10.0-lb/rm) precoat

1	7	86	56	26	0.48	3.76 (8.3)
2	14	91	62	30	0.44	3.76 (8.3)
3	21	96	73	33	0.49	3.31 (7.3)
4	28	96	75	37	0.57	3.17 (7.0)
5	35	93	67	28	0.51	2.26 (5.0)

Base stock: no precoat

6	7	84	49	20	0.67	4.35 (9.6)
7	14	89	52	20	0.65	3.85 (8.5)
8	21	89	48	22	0.68	3.17 (7.0)
9	28	93	58	24	0.66	3.22 (7.1)
10	35	94	48	24	0.64	2.94 (6.5)

Cast Coated Example

	--	84	53	27	0.53	--
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Note: Parker Print Surf determined by TAPPI T555 fpm-94,  
as corrected 1997, at a clamp pressure of 10 kg.

Example 2

[0026] Laboratory studies were conducted using 1.0 micron diameter hollow sphere pigment and 0.45 micron diameter solid bead plastic pigments. A pilot coater was used to apply the coatings at 800 Fpm, supercalendering was done at 244 meters per minute (800 fpm). Base stock was precoat with either 3.99 kg/278.7 m<sup>2</sup> or 0.90 kg/278.7 m<sup>2</sup> (8.8 lb/rm or

2.0 lb/rm) coating prior to high gloss top coat application. Results are found in Tables 2 and 3. Supercalendering was less intense for this trial, resulting in overall lower gloss values than Example 1. For both base stocks, with hollow sphere plastic pigment (conditions 1, 2 and 3) at 15% or 21% total pigment, paper gloss, print gloss, and smoothness were better than or equal to the cast coated example. At weight percent addition levels comparable to the hollow sphere pigment, paper gloss using the 0.45 micron diameter solid bead pigment (conditions 4, 5, and 6) were lower than both the hollow sphere pigment data and cast coated data. However, print gloss and smoothness were equivalent. using a mixture of hollow sphere and 0.45 micron solid sphere pigments, (conditions 7 and 8), resulted in properties equivalent to hollow sphere pigment alone.

Table 2

Condition	% Coating Pigment	75° Paper Gloss	60° Paper Gloss	20° Paper Gloss	Parker Print Surf @ 10kg	Coat Wt. kg/ 278.7 m <sup>2</sup> (lb/rm)
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Base Stock: 3.99 kg/278.7 m<sup>2</sup> (8.8 lb/rm) precoat

Plastic Pigment: 1.0 micron diameter hollow sphere

1	10	80	46	20	0.45	3.81 (8.4)
2	15	84	53	26	0.40	3.67 (8.1)
3	21	89	58	32	0.44	3.62 (8.0)

Plastic Pigment: 0.45 micron diameter solid bead

4	15	79	40	21	0.38	3.81 (8.4)
5	21	77	40	17	0.43	3.26 (7.2)
6	28	81	50	26	0.36	4.80 (10.6)

Plastic Pigment: 1.0 micron diameter hollow sphere

and 0.45 micron diameter solid bead, HP:SB

7	15:7	86	55	28	0.42	3.40 (7.5)
8	14:14	86	52	28	0.59	3.67 (8.1)

Cast Coated Example

	--	84	53	27	0.53	--
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Table 3

Condition	% Coating Pigment	75° Paper Gloss	60° Paper Gloss	20° Paper Gloss	Parker Print Surf @ 10kg	Coat Wt.kg/ 278.7 m <sup>2</sup> (lb/rm)
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Base Stock: 0.91 kg/278.7 M<sup>2</sup> (2.0 lb/rm) precoat

Plastic Pigment: 1.0 micron diameter hollow sphere

1	10	83	47	26	0.62	4.44 (9.8)
2	15	88	55	27	0.52	4.08 (9.0)
3	21	90	59	30	0.56	4.21 (9.3)

Plastic Pigment: 0.45 micron diameter hollow bead

4	15	81	48	27	0.54	4.58 (10.1)
5	21	80	45	23	0.61	4.26 (9.4)
6	28	85	50	31	0.53	4.67 (10.3)

Plastic Pigment: 1.0 micron diameter hollow sphere

and 0.45 micron diameter hollow bead, HP:SB

7	15:7	89	60	32	0.47	4.67 (10.3)
8	14:14	90	60	35	0.52	4.80 (10.6)

Cast Coated Example

	--	84	53	27	0.53	--
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Example 3

[0027] Solid sphere plastic pigments with diameters of 0.20 micron and 0.45 micron diameter were compared. Weight percent of coating pigment was increased to 40% with the intent of improving the effectiveness of the 0.45 micron pigment. Table 4 shows that even at 40%, the 0.45 micron pigment was ineffective for gloss development. However, using

the 0.20 micron bead at 40% addition gave a 75° paper gloss of 88 as shown in Table 4.

Table 4

Condition	% Coating Pigment	75° Paper Gloss	60° Paper Gloss	Parker Print Surf @ 10kg	Coat Wt.kg/ 278.7 m <sup>2</sup> (lb/rm)
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Base Stock: 0.91 kg/278.7 m<sup>2</sup> (2.0 lb/rm) precoat

Plastic Pigment: 0.45 micron diameter solid bead,

HP:SB

1	40	79	41	0.76	5.03 (11.1)
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Plastic Pigment: 0.20 micron diameter solid bead

2	40	88	57	0.60	5.71 (12.6)
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Example 4

[0028] High gloss paper coatings containing about 20% hollow sphere plastic pigment were applied with a high speed commercial coater at 762-823 meters per minute (2500 to 2700 fpm). In ten trials, paper was supercalendered over a broad range of conditions. Calendar speed ranged from 305-427 meters per minute (1000 to 1400 fpm), heated roll internal temperatures were 680-862 kg per linear 2.54 cm (100 to 240°F), and calender loads ranged from 1500 to 1900 pli. Typical results are shown in Table 5. Paper gloss and smoothness greater than or comparable to a cast coated sheet were obtained.



Table 5

Condition	% Coating Pigment	75° Paper Gloss	60° Paper Gloss	Parker Print Surf @ 10kg	Coat Wt. kg/ 278.7 m <sup>2</sup> (lb/rm)
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Plastic Pigment 1.0 micron diameter hollow sphere

Base Stock: 0.91 kg/278.7 m<sup>2</sup> (2.0 lb/rm) precoat

1	20.8	97	71	44	0.62	4.08 (9.0)
2	20.8	93	67	34	0.64	4.08 (9.0)
3	20.8	94	67	38	0.66	4.08 (9.0)
4	20.8	96	69	44	0.65	4.08 (9.0)

Cast Coated Example

--	--	84	53	27	0.53	--
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[0029] It will therefore be seen that the coated paper product of the present invention can be manufactured on existing high speed papermachines using conventional processes. The favorable effect of the plastic pigment to the coating is exhibited within the range of from about 14-35% addition. The most favorable effect is obtained with the use of hollow sphere plastic pigment having a diameter of about 1.0 micron. Gloss development of the product is achieved by the flattening of the plastic pigment particles between existing particles of other pigments during the calendering process.

[0030] While the prior art discloses in general the use of plastic pigments in paper coatings, none discloses the use of the elevated amounts required to achieve the results of the present invention. It is speculated that such pigments have only been sparingly used in the past because of cost considerations and the rheological problems encountered with the use of such pigments. Nevertheless, applicants herein have managed to overcome these problems and create a product that is competitive with conventional cast coated products.

[0031] While the preferred forms of the invention have been described in the Examples, variations will be apparent to those skilled in the art. Thus the invention is not limited to the embodiments described and modifications may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

#### Claims

1. A coating composition which may be used to coat a surface, preferably at least one paper surface, comprising a pigment composition comprising by weight from about 14-35% of a plastic pigment selected from the group consisting of hollow sphere pigments and solid bead pigments.
2. The coating composition of claim 1 wherein said pigment composition comprises a solvent, preferably water thereby being an aqueous coating composition.
3. The coating composition of claim 2, wherein said solvent, preferably water, is present in a amount sufficient to provide a coating composition with a solids content of from about 45 to 60 %.
4. The coating composition of one of claims 1 to 3, wherein said pigment composition comprises from 14-35 % plastic pigment selected from the group consisting of hollow sphere pigments and solid bead pigments; 46-60 % calcium carbonate, about 0-33 % coating clay and water in an amount sufficient to provide to said composition a solid content of from about 45 to 60 %.

5. Use of the coating composition according to any one of claims 1 to 4 for coating a surface, preferably at least one surface of paper, in one or more coating layers, advantageously to form at least the final coating layer.
6. A coated paper having applied to at least one surface thereof the dried residue of from about 2.72 to 8.16 kg/278.7 m<sup>2</sup><sub>A</sub> (6-18 lbs/ream) ream size 278.7 m<sup>2</sup><sub>A</sub> (ream size 3300sq. ft.) of said coating composition as defined in any of claims 1 to 4, preferably an aqueous coating composition.
7. The coated paper of claim 6, having at least a final or apparent coating layer coated with said coating composition, said paper exhibiting a 75 degree paper gloss of at least about 90, a 60 degree paper gloss of at least about 55, a 20 degree paper gloss of at least about 35, and a Parker Print Surf of from about 0.44 to 0.65.
8. A method of manufacturing a coated paper having high gloss and brightness comprising applying to at least one surface of the paper of a coating composition, preferably an aqueous coating composition, as defined in anyone of claims 1 to 4, in one or more coating layers, wherein the final coating layer comprises, by weight, from about 14-35 % plastic pigment selected from the group consisting of hollow sphere pigments and solid bead pigments.
9. The method of Claim 8, wherein the paper is a paper rawstock having a basis weight of at least about 18.14 kg/278.7 m<sup>2</sup><sub>A</sub> (40 lbs/rm) (ream size 3300 sq. ft.).
10. The method of claim 8 or 9, wherein the coated paper is finished in a supercalender device by passing the paper through a plurality of nips at a load of from about 680-907 kg/linear 2.54 cm (1500-2000 pli), wherein at least one of the nips includes a heated roll having a surface temperature of from about 37.7-115.4 °C (100-240 degrees F.) in contact with the coated surface of the paper.
11. The method of one of claims 8 to 10, comprising obtaining or preparing a paper having high gloss and brightness suitable for printing high quality graphics wherein at least one surface thereof contains from about 2.72-8.16 kg/278.7 m<sup>2</sup><sub>A</sub> (6-18 lbs/ream) of the dried residue of a coating composition, preferably and aqueous coating composition, said coating composition including a pigment composition comprising coating clay, calcium carbonate and plastic pigment, said plastic pigment consisting essentially of hollow spheres and/or solid bead particles ranging in size from about 0.20-1.0 micron, wherein at least about 18 % of the printing surface contains plastic pigment to achieve a 75 degree paper gloss of at least about 90, a 60 degree paper gloss of at least about 55 and a 20 degree paper gloss of at least about 35.

